THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VII.—No. 155.

## WILLIAM FOTHERGILL-COOKE.

ON the 25th of June, Sir William Fothergill-Cooke died at Farnham, in the seventy-third year of his age. Born at Ealing in 1806, he was educated at Durham University, where his father gave lectures on physiology, besides practising as a physician in the town. From Durham young Cooke was sent to Edinburgh University, and subsequently, in his twentieth year, he went to India, in the service of the East Indian Army, where he held several staff appointments.

Five years later, in 1831, he returned to Europe, and devoted himself to the study of anatomy and physiology at Paris and Heidelberg; but being one day, in March, 1836, in the lecture-room of Professor Moncke, he witnessed the operation of an experimental telegraph which the professor was exhibiting to his class, and from that hour the whole course of his life was altered. The young Indian officer and medical student had at that early day not occupied his mind with the new electrical researches which were engaging the minds of natural philosophers, but Moncke's experiment brought them before his notice, and henceforth he forsook all his other studies in order to develope the electric telegraph and make it the practical instrument which he believed it could be made. While others were toying with the new invention, Cooke took it up in grim earnest, and, three weeks after seeing Professor Moncke's illustration, he had devised a practical working telegraph based on the same principle, namely, the electro-magnetic discovery which Oersted had made, and Gauss and Weber had applied in their experimental line between the University and the Observatory of Gottingen. This plan of Cooke's included a key for interrupting the circuit, a battery, and three separate wire circuits, each having a going and returning wire, and a rough galvanometer or needle instrument, while a kind of switch was also employed to change the connections. The same year he also invented an ingenious mechanical telegraph, in which the current, by means of an electro-magnet, released a rotating drum set with pins, like the barrel of a musical-box, and moved a dial-plate marked with letters and figures until one of the pins made a contact and broke the circuit, when the dial came to rest exposing the desired signal letter to view. Applying this apparatus he met with a difficulty in determining the strength of current necessary to operate the electro-magnetic detent, and, after consulting Faraday and Dr. Roget, he referred himself to Professor Wheatstone, who was then engaged in electrical researches at King's College. Their meeting took place on February 27th, 1837, and Wheatstone showed him an experimental line which he had also fitted up on the Oersted principle. Cooke soon induced Wheatstone to join forces with him for the production of a practical public telegraph, and they entered into a partnership with Mr. Ricardo, M.P. Their first patent was dated June 12th of the same year, and it described the original five needle Cooke and Wheatstone instrument, so well known to every electrician, with its upright diamond-shaped face and five needles. Five circuits were necessary to work this apparatus, a fact which caused its final abandonment. It was tried first on the Great Western Railway, between the Paddington terminus and the West Drayton station, a distance of thirteen miles, in the winter of 1838-9, and opened for public messages. This was the first public telegraph in Great Britain, and as it was chiefly due to the ingenuity and enterprise of Mr. Cooke that it was introduced, he is well entitled to be called the father of English telegraphy.

In 1842 this line was extended to Slough, and became notable for the clever capture of a murderer named Tawell, by means of the five needle instrument now in the possession of the Post Office. Meanwhile other short lines had been erected, including one on the Blackwall Railway in 1841; and in 1844 the new telegraph was tried on a crucial scale upon a Government line from London to Portsmouth.

Mr. Cooke was honoured for his eminent public services with the Royal Albert medal of the Society of Arts in 1863. Three years later Her Majesty created him a knight in recognition of his great and special achievements in connection with the practical introduction of the electric telegraph; and, in 1871, he was granted a Civil List pension of £100 a year. His latter years were spent in seclusion, and he has passed away almost unheeded by the people at large: for, although his name lives in their memories, his work belongs now to the past, with that of Wheatstone and Morse.

## MUIRHEAD AND WINTER'S QUADRUPLEX SYSTEM (FOR LAND-LINES).

As is well known, the solution of the problem of quadruplex telegraphy depends upon a successful system of "diplex" telegraphy, that is, a method of sending two messages in the *same* direction at the same time; this system being obtained, the duplexing of it is an easy matter. Messrs. Muirhead and Winter in their system of quadruplex

FIG. 1.

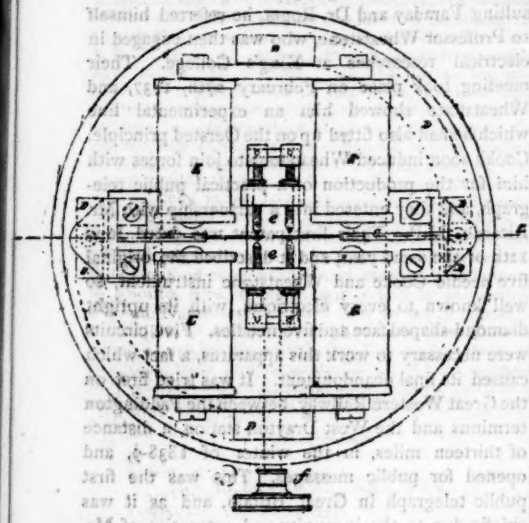


FIG. 2.
Section thro C. D.

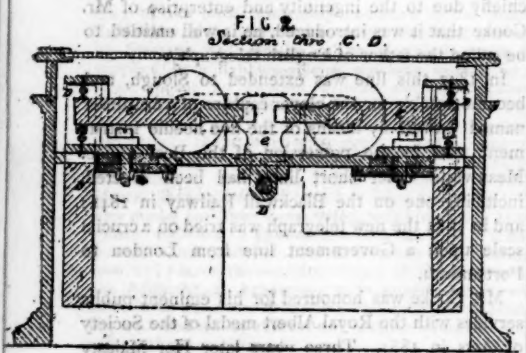


FIG. 3.

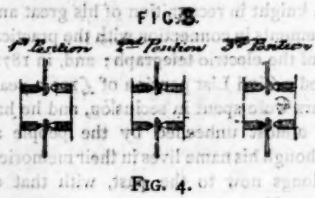
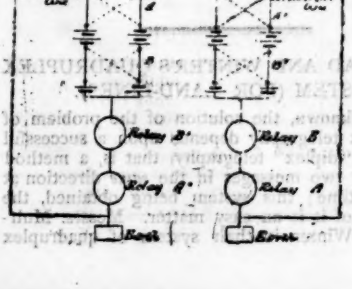



FIG. 4.




telegraphy have employed a somewhat novel method of "duplexing" their "diplex" system, which is worthy of publication.

In the diplex arrangement at the transmitting station the two keys are so arranged in connection with batteries that in the several positions of the keys the battery strengths flowing out to the line are as follows :—

| | |
|---|---|
| Both keys at rest, | + 3 |
| Key B depressed, A at rest, | + 1 |
| Both keys depressed, | — 1 |
| Key A depressed, B at rest, | — 3 |

The arrangement of the keys and connections by which this is effected will be described further on.

At the receiving station there is a polarised relay adjusted to break the local circuit when the current is plus, and to complete it whenever the current becomes minus; a local sounder or other receiver connected with this relay records the depressions of key A.

There is also in the main current at the receiving station a double tongued relay, which is used for completing the circuit of the sounder or receiver intended to respond to the movements of the key B.

This double relay, which forms an important feature of the system, is so arranged that in order that the local circuit should be completed, it is necessary for both tongues to be against their respective contact points. To accomplish this either the tongues are insulated and the contact between tongue and tongue caused to be completed through the contact points, which in this case are connected electrically with each other, or the contact points are insulated and the contact between point and point is completed through the tongues, which in this latter case are of course connected together.

The polarity and adjustment of the tongues is so arranged that the contact between one tongue and its point is only broken when the current is + 3, and that between the other tongue and its point is only broken when the current is — 3. With the intermediate strengths of + 1 and — 1 both tongues are in contact with their points, and the circuit of the relay is complete. Thus the local circuit is broken when the current is either + 3 or — 3, but it is closed when the current is either + 1 or — 1.

Both the contact points are fixed to the same carrier, and the arrangement is such that when once the contact points have been individually adjusted, their further adjustment for ordinary changes in strength of the currents is made simultaneously by one and the same motion of the carrier.

Figs. 1 and 2 represent respectively a plan and section of one form of the double tongue relay. In this form the tongues C C are polarised with like polarity by the permanent magnets D D. The tongues are insulated from the framework of the relay and from each other, and contact between them is established when both tongues are against their respective contact points, which are fixed to a single carrier and on one side of it; the screws on the other side of the carrier have insulated points.

The electro-magnets E, E, E, E, are polarised by the ends of the permanent magnets D D, the other ends of which polarise the tongues, so that all four poles of the electro-magnets have the same polarity.

The result of this arrangement is that, when the relay is acted upon by the currents + 3, + 1, and — 3 respectively, the tongues take up the respective positions shown by fig. 3.

After the first adjustment of the tongues, their further adjustment is made by moving the whole carrier *e e*, by means of the slow motion screw *f*, which works in a nut underneath the carrier.

It is evident that the action of any current passing through the coils of the electro-magnets, which are wound in the usual manner, is to cause the electro-magnets to act oppositely on the two tongues in consequence of the opposite polarity; thus, if a plus current tends to cause the one tongue to move in the direction of its insulated point, a minus current will have the same effect on the other one. The adjustment of the tongues is such that it requires a strength of + 3 to act thus upon the one tongue, and — 3 to act in the same way on the other tongue. If the current has either of the intermediate strengths of + 1 or — 1, the strength is insufficient to move either of them against the bias given them against their contact points, and consequently both tongues are in contact with their respective contact points, and the local circuit of the relay is complete. When the current changes rapidly from + 3 to — 3, the one tongue leaves its contact point before the other tongue has time to make contact. It is only when this change is retarded that any difficulty is experienced in working the local instrument B direct with this relay. If the instrument is a recorder the signals are perfect, as the effect of retardation is only to cause a slight trembling of the armature against its upper limiting stop, and is insufficient to affect the record. With sounders this is an inconvenience which can be remedied by using an extra local relay to complete the circuit of the sounder, the local circuit through the coils of which extra relay being completed by the double relay described.

In duplexing the "diplex" system a method of "double substitution" is employed. This system consists in placing the battery between the true and artificial lines, and connecting the receiving apparatus between the middle of the battery and earth. In order to give a signal the battery is reversed. Thus supposing copper to be connected to the true, and zinc to the artificial line, while the key is at rest, the depression of the key will join zinc to the true and copper to the artificial line.

In this arrangement perfect balance is obtained when the true and artificial lines are equal, and balance is perfectly independent of any changes in the resistance and electro-motive forces of the two halves of the battery, any inequality in which will merely cause a current to flow through the receiving instrument, but which current will remain the same whether a signal is being sent or not, that is, whether the battery is direct or reversed. The arrangement will be understood from fig. 4.

In this arrangement the keys B and $B^1$ separate the batteries into two portions, one of which contains $2n$ cells, and the other $n$ cells. When these keys are at rest the connections are along the continuous lines, and the two portions of the batteries are acting in the same direction, so that the current is $2n + n = 3n$. When these keys are depressed they reverse $n$ cells of the battery, so that there are only $2n - n = n$ cells acting. The keys A and $A^1$, when depressed, simply reverse the current, whether it is $3n$ or only $n$ as before.

It will be seen that as far as the receiving instrument and batteries are concerned it is really the true and artificial lines which are affected by the reversing key. They mutually replace one another in two portions of the circuit external to the instrument and batteries. There has, therefore, been given the name of "double substitution" to this form of duplex working, which, although similar in appearance to the split battery system, differs from it essentially in principle, for whereas in the split battery system balance depends on the maintenance of a strict proportion between the electro-motive forces of the two halves of the battery and the resistance of the true and artificial lines, the balance in the method of double substitution depends only on the equality of the true and artificial lines, which, however, experience shows may differ widely without affecting the received signals injuriously.

The principal merits claimed for this plan are,—

1. Its very wide working range. The artificial line may be altered within wide limits without affecting the signals.

2. The fact that the plan requires no special winding of the coils as in the differential system.

3. That the sensitiveness of the relay is not reduced, and magnetic retardation increased by the shunting action of bridge wires, as in the bridge span.

4. The balance, as stated above, is not disturbed by variations in the electro-motive forces or resistances of the two halves of the battery, as is the case in the ordinary split battery system. In addition to this, the action of the signalling on the distant instrument is of course doubled.

All that is necessary to neutralise any current which may be passing through the receiving instrument in consequence of inequality in the two halves of the battery is to join the receiving instrument slightly out of the centre of the battery. In order to do this effectually two or more of the middle cells of the battery may be shunted by a slide resistance equal to about three or four times the resistance of the cells so shunted, the receiving instrument being joined between the contact point of the slide and earth.

It will be noticed that the peculiarity in this quadruplex system consists in the duplexing portion and also in the form of double tongue relay. The arrangement of currents for the different positions of the keys is identical with that employed by Mr. Gerrit Smith, in America, but the latter gentleman employs his most ingenious, yet simple, compound relay, in the place of the double-tongued relay, and with great advantage.

## THE NEW FORM OF LECLANCHÉ BATTERY.

By Dr. H. TOBLER, Professor of the Zurich Polytechnic School.

THE old form of Leclanché battery possessed, as is well known, a very considerable resistance, and the employment of a porous pot was subject to many inconveniences, which have prevented the greater employment of this description of battery. In the

new and improved forms the inventor has dispensed with this porous vessel. The carbon electrode is surrounded with a mixture composed of 40 parts of pyrolusite, 155 parts of grain carbon, and 5 parts of resin, this latter substance acting as a cement. This composition is heated to 100° C., and subjected to a pressure of 300 atmospheres; it forms an homogeneous cylinder, in the axis of which is the carbon electrode. The inventor has given to this element the name of "conglomerate mixture" battery. These elements are extremely easy to manage; their electro-motive force is higher than that of the old form, and their resistance less. Under the influence of the current, the peroxide of manganese is reduced to the sesquioxide, a body which is not an absolute conductor of electricity. The conglomerate will then offer a more or less high resistance. Moreover, it fills up the pores of the conglomerate with considerable quantities of ammonia, which tends to decompose it. When completely exhausted, it becomes useless mass, which is only fit to be thrown away.

M. Leclanché has recently devised a new modification, which is made by attaching to the carbon depolarizing plates which can be renewed from time to time. The two or three plates are simply attached to the carbon by india-rubber rings.

As regards the value of this new form of Leclanché battery, in the *Traite de la pile electrique* of Niaudet, the electro-motive force is set down as 1·6 that of a Daniell, and as regards its resistance, M. Barbier states that it exceeds that of an iron wire 400 metres long and 4 millimetres in diameter. The present investigation was made in order to determine the precise value of the battery.

Amongst the different methods devised for testing the resistance of galvanic elements, that of Mance is remarkable for the exactitude of the results it gives, and this was in consequence, the method chosen. In order to determine the electro-motive force, I have employed a condenser of ·5 microfarads' capacity, and have measured the discharge from it on a Thomson galvanometer.

*Resistance Measurements.*

I. An ordinary element of the No. 1 size, viz.: 140 millimetres high and 75 millimetres square, charged, according to the directions of the inventor, with 100 grammes of pure sal-ammoniac, and with water sufficient to three quarters fill the jar, gave a mean result of 1·131 S. U.

II. The same element, after working an electric pendulum on the Hipp system, and in which the current is broken during 80 or 90 seconds (resistance of electro-magnet 3 S. U.), gave a mean resistance of 1·513 S. U.

III. After an interval of two days, during which the element was not worked, the measured resistance was 1·153 S. U.

IV. Five old conglomerate elements were tested. These elements had been joined up at the end of December, 1878, and were since that date often employed for the measurement of the capacity of gutta-percha wires. The mean values attained were as follows:—

| | | | | | |
|---|---|---|---|---|---|
| Element No. | 1 | ... | ... | 2·52 | S.U. |
| " | " 2 | ... | ... | 1·32 | " |
| " | " 3 | ... | ... | 1·51 | " |
| " | " 4 | ... | ... | 1·33 | " |
| " | " 5 | ... | ... | 1·32 | " |

Element No. 1 had been employed frequently for working the electric pendulum before referred to. These experiments have confirmed the assertions of M. Leclanché that long use increases the resistance of the conglomerate.

V. A new element with moveable conglomerate plates. The height of the battery being 145 millimetres, and width 90 millimetres. Charged in the same way as the preceding one.

The measurement being taken about an hour after the liquid had been placed in the vessel, the resistance was found to be 1·370 S.U.

VI. The same element measured two days later gave ·736 S.U.

VII. The measurement being repeated a day later gave ·718 S.U.

*Electro-motive force measurements.*

As a standard I took a Daniell element, carefully prepared. The specific weights of the solution being kept as nearly constant as possible.

I. The element indicated under the previous headings I., II., and III.

1. Two hours after being charged, the electro-motive force was 1·46.

2. Two days later the result was 1·48.

II. The 5 old elements, indicated under the previous heading IV, gave the following results:—

1.

| | | | | |
|---|---|---|---|---|
| Element No. | 1 | ... | ... | 1·43 |
| " | " 2 | ... | ... | 1·32 |
| " | " 3 | ... | ... | 1·51 |
| " | " 4 | ... | ... | 1·33 |
| " | " 5 | ... | ... | 1·32 |

2. Measurements two days later, the batteries having rested in the meantime:—

| | | | | |
|---|---|---|---|---|
| Element No. | 1 | ... | ... | 1·43 |
| " | " 2 | ... | ... | 1·40 |
| " | " 3 | ... | ... | 1·45 |
| " | " 4 | ... | ... | 1·43 |
| " | " 5 | ... | ... | 1·43 |

III. The element with renewable plates, indicated under the previous headings V., VI., and VII.

1. One hour after being charged

1·41.

2. Immediately after the measurements V. and VI.

1·38.

3. After the measurements VII.

1·40.

4. Three days after the measurements VII., the element not having been used in the interval

1·43.

It is certain from these experiments that the electro-motive force diminishes rapidly when the resistance is low, but that it recovers rapidly when the battery is at rest. The Leclanché element will not answer, therefore, for all purposes; thus, for example, the battery could not be employed on a closed circuit, or where the circuit is often closed. In other cases it is a useful battery, on account of its high electro-motive force and its low internal resistance.

## THEILER'S PATENT MECHANICAL DUPLEX (FOR LAND-LINES).

DUPLEX working either on the "differential" or on the "bridge" principle, is now universally known and understood, and if the essential features of those systems are referred to in the present article, it is only in order to show clearly in what respects this new duplex system differs from all others.

In both the differential and the bridge method, the current is split between an actual and an artificial line; and it is absolutely necessary that a certain ratio of current be kept up between the two circuits so as to produce a "balance." But, considering that the resistance and the electrostatic capacity of a line, from a multiplicity of causes, varies constantly and considerably (in bad weather the resistance may vary as much as 50 per cent. in one day), and that variation in the resistance and static capacity of the line means alteration in the adjustments of the apparatus, it must be conceded that duplex working, either on the differential or bridge principle, looks simpler on paper than it is found to be in practice.

In Theiler's mechanical duplex, the current is not split between two circuits, and as no equality of currents has to be maintained, variation in the resistance of the line, be it even as much as 100 per cent., does not affect the apparatus. There are no condensers, no rheostats, and the only adjustment required is that of the relay, just as in ordinary single working.

An explanation of the diagrams fig. 1 and fig. 2, which represent the *theoretical* construction of the apparatus, will show how signals, electrically neutralised by simultaneous sending from opposite stations, are recorded mechanically.

The key lever *e*, whose motion is limited by the stops *a*, *b*, carries a spring *f*, which is insulated at the point where it is fixed to the lever of the key which touches this lever at the extremity *h* of the latter. This spring impinges on the tongue *l* of the polarised relay *m*, *m'* when the key is depressed, but does not touch *l* when the key is at rest. The (polarised) relay may be of any form, but is preferably a "Theiler's,"* as that construction allows of a convenient and nice adjustment of the electro-magnet. The armature (which is induced at the centre *c*, so that both ends have similar polarity) is adjusted that the tongue *l* has a bias towards stop 2, stop 1 being in connection with the receiving instrument, Morse or Sounder.

Now when one of the keys (connected to earth) is depressed upon the front stop *b*, as shown in fig. 2, the end of the spring *f* touches the tongue *l*, and meeting an obstacle bends, and thereby breaks contact with the lever at *h*, consequently a current flows from the copper pole of the line battery through the tongue *l*, the spring *f*, the electro-magnet *m*, *m'*, to line, and entering the relay of station II. returns through the spring *f* and the lever *e* to earth.

The effect of this current upon the relay at station II., is an *increased* pressure of the tongue *l* against stop 2, which resists all tendency of the spring *f* to move the said tongue against stop 1,

* See TELEGRAPHIC JOURNAL, Vol. V., page 207.

FIG. 1.

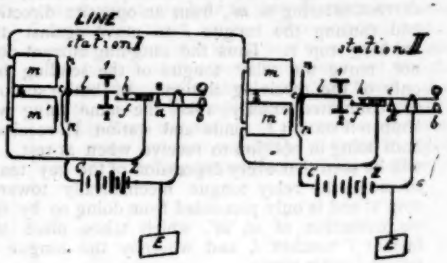



FIG. 2.

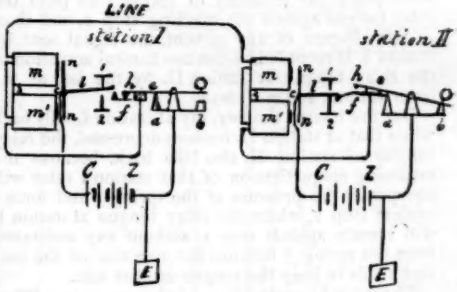
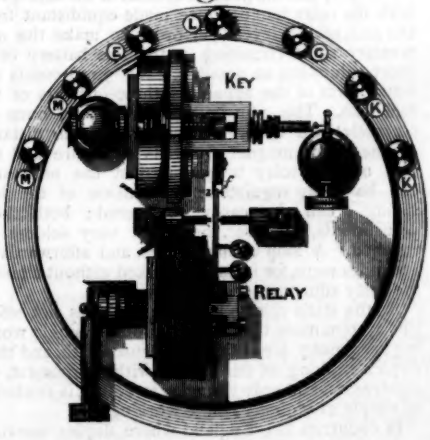



*Fig. 3.*



while the effect of the current upon the relay of the receiving station is exactly reversed, the current entering *m*, *m'*, from an opposite direction and causing the tongue *l* to move against the marking stop 1. Thus the outgoing current does not move the relay tongue of the sending but only of the receiving station. As both stations are connected exactly alike, the same thing will happen if station I. sends and station II. receives, both being in position to receive when at rest. It will be seen that every depression of the key tends to move the relay tongue mechanically towards stop 1, and is only prevented from doing so by the magnetisation of *m*, *m'*, which takes place the instant *f* touches *l*, and whereby the tongue is forced against stop 2.

If no current were to flow through the magnet of the sending station relay, then the key would produce its signals at its own station. Such is actually the case when both stations send simultaneously. Then the copper pole of station I. opposes the same pole of station II., and contact with earth being broken, no current goes to line; nothing now counteracts the tendency of spring *f* to push the relay tongue against the marking stop 1, and thus, in the absence of any current, the signal sent by station I. is recorded by the mechanical actuation of the relay tongue at station II. by the key of the latter station, and *vice versâ*.

But the instant the key, say at station I. falls back while that at station II. remains depressed, the relay tongue of station II. also falls back, because the returning magnetization of that station's relay will overpower the pressure of the spring *f* and force *l* against stop 2, while the relay tongue at station I. will remain against stop 1 without any assistance from the spring *f*, because the direction of the current tends to keep the tongue on that side.

The actual construction of the apparatus differs somewhat from that illustrated by figs. 1 and 2. In order to render the motion of the lever *e* exact, decided, and as small as possible, it is preferable to effect it by means of an electro-magnet, and to use an ordinary key merely to make and break connection with that electro-magnet and a local battery. In practice, the point of contact of the spring *f*, with the lever *e*, and the point of contact of the said spring with the relay tongue *l* are made equidistant from the axis of the lever *e*, in order to make the momentary short circuiting of the line battery of as short a duration as possible. Fig. 3 represents the actual form of the apparatus, three-quarters of the real size. The adjustments of the key, once set correctly, are never touched, while the distance of the relay magnet from its armature and the bias of the relay tongue against the next stop can be easily regulated; the tension of the line spring *f* can also easily be altered; both these adjustments, however, need but very seldom be touched. A loop circuit of 200, and afterwards of 400 miles were, for instance, worked without altering the relay adjustment.

As the static charge from the line does not affect this system more than it does ordinary single working condensers are entirely dispensed with, and thus duplex working on this system with no rheostat, no condensers, and only the relay to adjust, is rendered as simple as ordinary single working.

In countries like England where duplex working has been extensively established for some time, and a change in the present system would necessitate change in a large stock of duplex apparatus, it will be difficult, perhaps, to get adopted *any* new duplex system until increased traffic calls for a greater number of duplex circuits.

But in countries where duplex working is only just gaining a footing, this mechanical duplex ought to have a splendid field. From its simplicity the system, also, appears particularly applicable to military field telegraphy. Where telegraphic lines are very long, two sets of the above apparatus, suitably connected to the "up" and "down" line, are used to act as a duplex translator.

We understand that the inventors of the Mechanical Duplex will shortly bring out a duadruplex on a similar principle.

## LIGHT FROM ELECTRICITY.

WHETHER the electric light be produced by incandescence, or by the voltaic arc, the problem of producing a satisfactory result consists in the first place of arranging all the effective resistances that the maximum possible portion of the total heat generated in the circuit may be made use of.

Now, when the flow of electricity has become steady, and in the case where the positive electrode is in a condition to remain in a state of dynamic equilibrium, or is in a condition so to modify constantly the variable elements as to practically produce a state of equilibrium, then the body of which the resistance is formed takes an equilibrium of temperature corresponding to the luminous state, which is an exponential function of that temperature. This very rapid increase of luminous intensity with temperature is entirely in favour of powerful electric currents, and everything else being equal, to the disadvantage of division.

Supposing a table of luminous intensities corresponding to temperatures to be drawn up, the problem resolves itself into the determination of the temperature of the surfaces of emission. We must first endeavour to calculate directly this temperature by determining the number of caloric units generated in unit time in the effective resistance, by taking account of the mass of the working body, of its surface, of its caloric conductibility, of its specific heat at different temperatures, of the loss by radiation through particular mediums, &c.; but considering the numerous causes of error to which the introduction of so many elements, more or less doubtful would give rise, it would seem better to determine by direct experiment the temperatures to which the luminous emissions correspond in the particular medium, and to observe them at the moment when equilibrium will be established; the loss by radiation exceeding the loss by contact with the rest of the circuit in a second of time is precisely equal to the quantity of heat generated by the current in the working resistance. This quantity of heat being known, the expression of the emission as a function of the temperature allows of this latter being determined.

It seems, then, from recent researches, that the intensity of a radiation of a given refrangibility,

caloric or luminous, does not increase indefinitely with increase of temperature, but only up to a maximum corresponding to a certain temperature, and decreases afterwards until it becomes insensible at a fixed point and also that it does not become appreciable until it reaches a certain temperature.

It is thus with the red light rays, which commence to be perceptible at about 500° C., and the light of which increases at first very rapidly up to about 1,933° C., the intensity then being 696 times as great as it is at 954° C. (the temperature of melting silver); after this a decrease takes place, and at 2,910° C., the intensity of these red radiations would not be greater than unity.

If $a$ represent the intensity or the quantity of the total heat emitted by the unit of surface, then $\Sigma \, A \, a^t$ will be the sum of the intensities of all the radiations of the heat of different refrangibilities at the temperature $t$, each of the values of $a$ decreasing with the temperature, in the proportion of $\log. a : m - n t$, a kind of compensation established by the predominance, more and more marked, of the terms introduced by the most refrangible radiations of which the exponential base is greater. It therefore follows that a formula of the form $A \, a^t$ can, in limits sufficiently broad, express the intensity of the entire radiations.

For a cylindrical surface of diameter $d$ and length $l$, W being the quantity of heat generated in the working resistance, we have $W = \pi \, d \, l \, A \, a^t = B \, a^t$ from which

$$t = \frac{\log. W - \log. B}{\log. a}.$$

The temperature being determined, the total luminous intensity will be given by the formula $c \, c^t$, applicable to the luminous radiations of every refrangibility or by the known formula

$$\frac{f(t-\theta)}{b\,(e-1)}.$$

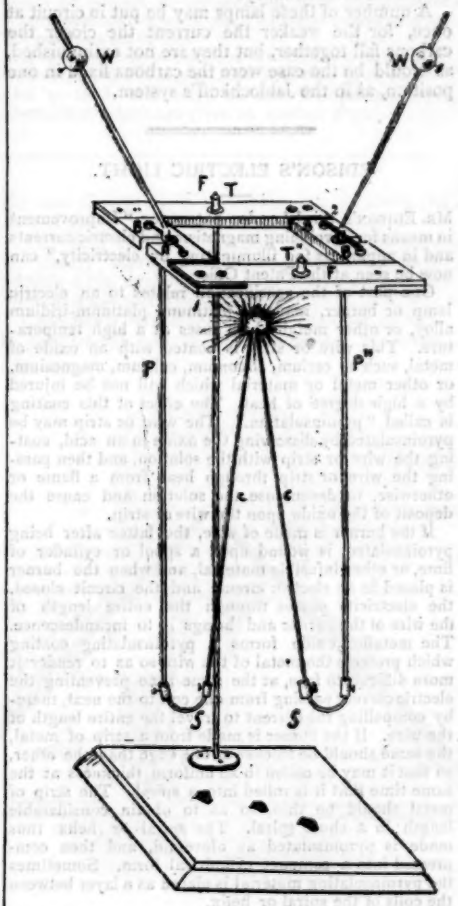
The ratio between the intensity thus determined and the mean intensity of a Carcel burner, for example, taken as a unit multiplied by the ratio between the projection of the light surface upon any plane and the projection upon a vertical plane, of the light surface of the unit lamp, expresses in Carcel burners and in the direction perpendicular to any plane considered, the lighting powers, to the naked eye, of the light considered.—*La Lumiere Electrique.*

## HICKLEY'S ELECTRIC CANDLE.

THIS new repulsion lamp, or, more properly speaking, candle, is constructed upon the principle observed by its inventor, Mr. A. T. Hickley, Wilde, Jamin, and others, that the arc produced between two carbon pencils connected to an alternating current machine, causes the carbons to repel each other.

F, F is a brass frame made in two parts, each insulated from the other by ebonite or ivory at 1 and 2. Each piece is provided with terminals T, T″.

Two pendulums P, P″, swing freely in bearings B, B, B, B, which are in electrical contact with the terminals T, T″. These pendulums have levers at the top, upon which slide counterpoise weights w, w, which are held in their position by the thumb screws at their sides. Two carbons, 20in. long, about ¼ of an inch thick, are secured to the arms at the bottom of the pendulums, and the weights w, w, so adjusted that their points just touch. As soon as the circuit is complete, the current passes alternately from one carbon to the other, producing the arc, which at once causes the carbons to repel each other, according to the power of the current.




As the carbons are consumed they become lighter, which has the same effect as though the counterpoise weights became heavier; and so the carbons are kept together in trying to touch each other with the same force as they burn down to the bottom.

Should one candle in a series become accidentally extinguished, the carbons of the whole series at once fall together, thereby closing the circuit, and re-establishing the light.

An automatic switch can be attached to the axle of one of the pendulums at B, so that as soon as the carbons are nearly consumed the switch is liberated and contact is made between the two halves of the frame F, F, thereby cutting out that candle, but not interfering with the others which may be in circuit.

The rest of the drawing explains itself.

The form which we illustrate, was exhibited at the Royal Albert Hall in May last, and when connected to a Wilde's Alternating Machine (which was kindly lent for a short time), it burnt with great steadiness and brilliancy.

A number of these lamps may be put in circuit at once, for the weaker the current the closer the carbons fall together, but they are not extinguished, as would be the case were the carbons fixed in one position, as in the Jablochkoff's system.

## EDISON'S ELECTRIC LIGHT.

MR. EDISON'S third London patent for "Improvement in means for developing magnetism and electric currents and in apparatus for illuminating by electricity," can now be seen at the Patent Office.

One part of the specification relates to an electric lamp or burner, made of platinum, platinum-iridium alloy, or other metal which fuses at a high temperature. This wire or strip is coated with an oxide of metal, such as cerium, zirconium, calcium, magnesium, or other metal or material which will not be injured by a high degree of heat. The effect of this coating is called "pyroinsulation." The wire or strip may be pyroinsulated by dissolving the oxide in an acid, coating the wire or strip with the solution, and then passing the wire or strip through heat from a flame or otherwise, to decompose the solution and cause the deposit of the oxide upon the wire or strip.

If the burner is made of wire, the latter after being pyroinsulated, is wound upon a spool or cylinder of lime, or other infusible material, and when the burner is placed in an electric circuit and the circuit closed, the electricity passes through the entire length of the wire of the burner and brings it to incandescence. The metallic oxide forms a pyroinsulating coating which protects the metal of the wire so as to render it more difficult to fuse, at the same time preventing the electric current passing from one coil to the next, thereby compelling the current to travel the entire length of the wire. If the burner is made from a strip of metal, the same should be thicker at one edge than the other, so that it may be coiled to an uniform thickness at the same time that it is rolled into a spiral. The strip of metal should be thin, so as to obtain considerable length in a short spiral. The spiral or helix thus made is pyroinsulated as aforesaid, and then compressed into a compact cylindrical form. Sometimes the pyroinsulating material is placed as a layer between the coils of the spiral or helix.

The thermal regulators set forth in "Edison's" British patent of October 23, 1878, may be used for regulating the current or burners made of a wire or strip of metal, coated with a pyroinsulating material for the purposes aforesaid. This pyroinsulating coating allows of very fine wire being used for the burner. Hence several layers of the wire may be wound upon the spool of infusible material, and the burner will have a resistance of several hundred ohms, which permits of several hundred burners or lamps being connected quantitatively in multiple arc, without requiring large main conductors.

In some instances a burner or candle is made of finely divided iridium, or other metal not easily fused, mixed with an oxide of titanium, iron, or other metal, which acts as a conductor when highly heated. This is to be moulded into the desired form, and, by properly proportioning the mixture, the current to the burner is regulated by the heat of the said burner, the resistance being lessened in proportion to the heat.

Another feature of this invention relates to the arrangement of the main conducting wires, so as to obtain a complete metallic circuit, and at the same time take advantage of the conductivity of the earth, so that the mass of metal in one of the conductors may be reduced. The earth and metallic conductor serve at the same time as a protection for the insulated conductors.

The magneto-electric machines may be of any suitable character and driven by power. They may be arranged between two main conductors in ranges or multiple arcs of three, four, or more in each, and the connections should be for intensity. One is a tube laid in the earth, and preferably of iron, and it forms, together with the earth, one half of the circuit; within this tube is the other, viz., an insulated conductor, preferably of a number of strands of copper twisted together in the form of a cable, one strand of the cable being dropped, say, every hundred feet, so that at the extreme end of the circuit there shall be but a single strand. This cable is insulated from the tube by any cheap or economical insulation, such as tar or asphaltum. A branch tube containing a single strand from the cable is to enter each house or building, and from the basement smaller wires are run to the various parts of the house where the lights are required. Each lamp is to be provided with a switch, so that it may be disconnected from the conducting wires.

The electric generators at the central station are provided with constant field-of-force magnets, the helices of which are in the electric circuit. Hence, if all the lamps feeding from the main conductors are disconnected by their switches, the circuit will be broken, and no current passes through the conductors leading from the station to the lights. Hence the steam engine driving the magneto-machines runs lightly, and with the expenditure of a very small amount of force. If now the switch of a single lamp is turned, the lamp is connected to the branch wires from the main conductors, the circuit is closed, and only sufficient current passes from the central station to supply that lamp, because the external resistance determines the amount of current.

In this way the current will be proportioned to the number of lamps in the circuit. Each lamp is preferred to contain a resistance, when incandescent, of 1,000 ohms. As before described, the connecting of one or more lamps causes a sufficient amount of current to be developed at the central station to keep the same incandescent. It follows that, if the machines at the station are arranged expressly for tension and quantity, many hundreds of lamps may be placed in circuit between the main conductors, the reduction of resistance upon placing each lamp in circuit drawing the proper quantity of current from the station. Hence the greatest economy possible is obtained by causing all the resistance outside of the main conductors to be light-giving resistances.

Another part of the invention relates to means for storing the electric current or energy, so that the same may be used as required. This is effected by the use of secondary batteries, and there are devices described for shifting the current from one secondary battery to another periodically, so that one may be in use while the other is being charged from the main circuit.

The following are the "claims":—

1. An electric lamp or burner made of a wire or strip of metal coated with pyroinsulating material, substantially as and for the purposes specified.

2. The electric lamp or burner made of layers of metal with intervening pyroinsulation substantially as specified.

3. In combination with a burner formed of pyroinsulated metal, a metal case surrounding the burner, and made incandescent by the heat thereof substantially as specified.

4. The method of pyroinsulating the wire or strip of metal for the conductor, consisting in passing the wire or strip through a solution of lime, magnesia, or similar material, and then through heat from a flame to effect decomposition of the solution as specified.

5. The insulated metallic conductors within a metallic case which forms with the earth the return circuit substantially as specified.

6. The combination with electric lamps and a main circuit of two secondary batteries, and circuit connections and switch substantially as set forth to alternately change the main and secondary circuits substantially as specified.

7. The combination with a secondary battery and its enclosing case of a diaphragm, or similar device, acted upon by the accumulation of gas pressure, and a switch or lever moved by such diaphragm to disconnect the main circuit from the secondary battery substantially as set forth.

8. An electro-magnet in the same circuit as the lamps or burners in combination with an armature lever, latch, and contact piece substantially as and for the purposes set forth.

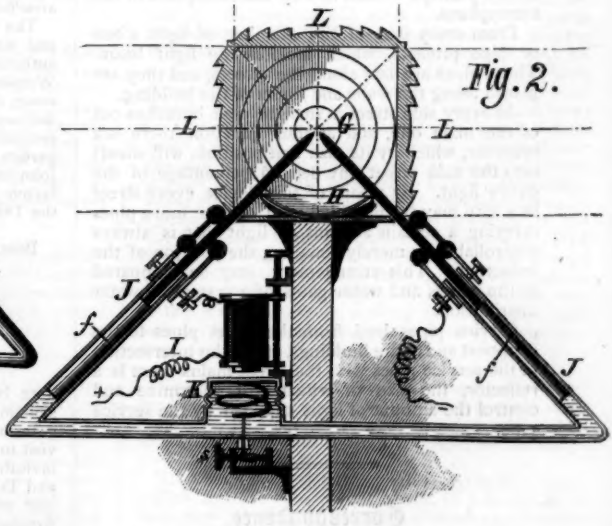
It is interesting to compare Mr. Edison's patent with that of Mr. St. George Lane Fox, No. 3988, of date Oct. 9, 1878, also 4043, of date October 12, 1878, abstracts of which are given on another page.

## DISTRIBUTING ELECTRIC LIGHT.

MESSRS. MOLERA AND CEBRIAN, civil engineers, of San Francisco, have conceived the novel plan of dividing the electric light by optically reflecting the beams and dealing them out at the required points in the required quantity, thus saving expensive regulator lamps and electrical conductors. A full account of the system is published in the *Scientific American*, to which we are indebted for the accompanying illustrations.

Fig. 1.

Fig. 2.




Messrs. Molera and Cebrian exhibit some very flattering figures based upon an expenditure of twenty horse-power, which, as we have already learned, is not sufficient to obtain the most advantageous results. They claim that they are able to produce by their system 195 lights per horse-power giving a light equivalent to 1,958 candles, and that the cost of lighting is less than one-twentieth the cost of gas.

The lamp used in connection with this system is so clearly represented in the engraving as to require little explanation. Fig. 1 is a perspective view, and fig. 2 is a vertical section.

Chamber G, which serves as a chamber of light, is surrounded on the sides and top by lenses, L. At the bottom there is a concave reflector, H, and at the centre two carbon rods converge. These rods are supported by pistons or floats in inclined tubes, J, which are connected at their lower ends by a horizontal tube communicating with the spring-acted bellows or cylinder, K. The tension of the spring that draws the top of the bellows down, may be changed by revolving the small windlass, *s*.

The top of the bellows is iron, and above it is supported an electro-magnet, which is in the

electrical circuit. The carbons pass between conducting surfaces, and are also in the electrical circuit. The tubes J, as well as the horizontal tube and the bellows, are filled with a suitable liquid. As the current passes from one carbon point to another the core of the electro-magnet becomes magnetised and attracts the head of the bellows with more or less force, maintaining a uniform light by governing the distance between the carbons by displacing the liquid in the tubes and throwing the pistons or floats up or down, according to the strength of the current.

Should the current cease the spring draws down the head of the bellows and the points of the carbons touch. When the current is too strong, the top of the bellows is attracted upward, and the carbons separate.

A single electric lamp placed near the current generator supplies light for a building or a street. This lamp is surrounded by a system of lenses and reflectors forming the chamber of light, as represented in Figs. 1 and 2. These lenses concentrate the whole of the light into as many beams of parallel rays as there are faces in the chamber. In this form the light may be projected through long distances. The intensity of the light when not condensed is inversely proportional to the square of the distance from the source of light, but when the light is projected in parallel rays and is prevented from radiating, its intensity remains unchanged, except perhaps a small loss by the absorption of the atmosphere.

From every face of the chamber of light a box or pipe projects, which incloses the light beam. These pipes are laid along the streets, and they are placed along the walls and floors of the building.

At every side street a smaller pipe branches out of the main one, and at their junction there is a reflector, which by its size and position, will divert into the side street any desired percentage of the entire light. By means of this device every street in a city may be provided with one or more pipes carrying a certain amount of light that is always controllable by merely changing the position of the reflectors. This arrangement may be compared to the valves and water gates of a system of water distribution.

Service pipes lead from the street pipes to the lamppost and to the buildings, and at the intersection of the service pipes with the street mains there is a reflector, the size of which will determine and control the amount of light supplied by the service pipe.

## Correspondence.

[We do not hold ourselves responsible for the opinions of our correspondents.]

*To the Editor of* THE TELEGRAPHIC JOURNAL.

SIR,—The telegraphic instrument described in your Journal of April last as the invention of M. Bramão, of Portugal, is but an elaborate modification of an apparatus designed to effect precisely the same end, and patented in 1854, by J. W. Wilkins, of Hampstead.

But for the mistake of launching a company (although the solicitors were Mansfield and Fews, and such names as Leaf and Rolt were on the Directory) in face of the Crimean War, the English patent would doubtless have been sufficiently well known, as not to admit of its re-introduction to-day as a Portuguese invention.

*July 4th*, 1879. JUSTITIA.

### THE INTERNATIONAL TELEGRAPH CONFERENCE.

SIR,—As there is some likelihood of a letter tariff being introduced at the Telegraphic Conference, to be held in London shortly, may I beg to draw your attention to the orthography of our language, which will, unless some provision be made for it, cause a deal of bother both for the Telegraph Companies and the public.

Dictionaries are at variance about such words as smalness—smallness; fulness—fullness; talness—tallness: miscal—miscall; enrol—enroll, &c., &c.

There is also a rule grossly violated by us to the effect that "words of more than one syllable, with the accent not on the final one, preceded by a single vowel do not double the final consonant before a vowel augment," *e.g.*—canceled, traveling, always spelt with two *l's*. This rule is seldom violated by Americans.

Should this letter tariff come into force, it will bring about a thorough overhauling of the rules of orthography, therefore, something should be done at the coming Conference to alleviate as much as possible this rather important question, which will inevitably arise between the public and the Telegraph Companies.

The public will gladly hand in the word smalness, and similar words with one *l*, quoting Johnson as their authority, whilst the Telegraph Companies will quote Webster as theirs; therefore, let public and Companies come to some agreement about rigorously adopting a dictionary for their guidance, and thus avoid a deal of confusion. It is worth careful consideration by both parties as to which dictionary be adopted, because Johnson, Walker, and Knowles, will be found to be in favour of the public, and Webster rather in favour of the Telegraph Companies.

I am, Sir, &c.,

Botany, Sydney, N.S.W. G. J. B.
*May 12th*, 1879.

## Notes.

THE INTERNATIONAL DELEGATES.—With the special sanction of the Secretary of State for War, the delegates of the International Telegraph Conference paid a visit to the Royal Arsenal, Woolwich, on July 2, on the invitation of the reception-committee of the Post Office and Telegraph Companies. The party left Blackfriars pier at half-past ten, and on arriving at Woolwich Arsenal were met by the heads of the departments, and were conveyed by the local railway to the Government marshes, where they witnessed the running of the fish torpedo in the Arsenal canal, and several important experiments with gun cotton. The visitors inspected the new 100-ton gun, and witnessed the firing of the Woolwich Infant. It was arranged that they should see the military balloon equipment; but a boisterous wind and a heavy thunderstorm prevented this being carried out. The party then partook of luncheon in the Carriage Department New Store, at which Sir James Carmichael, Bart., presided. They subsequently visited the Royal Gun Factories, Shell

Foundry, Royal Carriage Department, Royal Laboratory, and returned by steam-boat to London in the evening.

On the preceding Friday, June 27, the delegates visited Windsor Castle, and were afterwards entertained by Sir Daniel Gooch, M.P., at luncheon in the Windsor Town Hall. The unprecedented bad weather has, we regret to say, materially interfered with the enjoyment of the delegates; but by all accounts it is not confined to England alone, although we have certainly come in for the lion's share of it.

A CONTEMPORARY has published a translation of an article from a French paper stating that it requires six 18 h.-p. engines to drive machines for supplying 60 Jablochkoff lights. Against this we have it on good authority that recently a 20 h.-p. (nominal) Ransome's engine supplied 60 Jablochkoff lights on the Thames Embankment, and this for a period of three consecutive hours.

THE ELECTRIC LIGHT.—The Bill before the House of Commons, promoted by the Liverpool Corporation to give power to adopt and supply electricity for private and public lighting was petitioned against by the Liverpool Gas Light Company in Committee. It was, however, passed in an amended form, which limits the powers of the Corporation to the making of a scientific experiment in lighting, but does not allow them to compete with the gas company for purposes of profit.

THE Aldersgate and Edgware Road Stations of the Metropolitan Railway have been lit of late by electric light.

FLOWERS BY ELECTRIC LIGHT.—The shade of a flower varies notably, even in daylight, according as it is seen by the golden light of a southern clime, or under the blue sky of the north. They absorb, as is well known, the warm orange rays of the sun. M. Hugo has observed that the electric light modifies the tints of certain flowers. For example, the central tuft red foliage of the *Nidularium* is brightened in shade by the electric light, whereas the red spots on the leaves of *Caladium* are toned to a reddish brown.

THE TELEPHONE.—M. Decharme, from experiments made with vibrating plates of glass and metal, arrives at the conclusion that diaphragms of telephones should be fixed, not round their rims, but at a single central point. When so fastened they are most sensitive to external vibrations.

THE PHONOGRAPH.—M. Delecheneau has succeeded in getting phonograms on zinc and brass cylinders, by a process which he has not yet divulged.

THEORY OF THE MICROPHONE.—In *Wiedmann's Annalen*, VI., 403, Herr Aron discusses the subject, and assuming that the changes of resistance and current strength are indefinitely small in comparison with the total resistance of the circuit, and the strength due to the battery respectively, the author arrives at the following results:—(1) The different wave systems that traverse the circuit are superposable: (2) The change of phase is greater the higher the pitch of the note: (3) The amplitude, *i.e.*, the intensity of current change diminishes as the pitch rises, and the more so as the resistance and the electro-dynamic potential are greater. Large coils, therefore, in the circuit, are a disadvantage, especially if they have iron cores.

ELECTRICITY AND CATARACT.—Dr. W. B. Neftel, a physician of New York, is reported to have cured a case of incipient cataract by repeated applications of electricity to the diseased eye.

LEAKAGE FAULTS IN CABLES.—In the *Philosophical Magazine* for July, there is an interesting mathematical paper on this subject by Mr. Oliver Heavyside.

HIS EXCELLENCY M. COCHERY, the French Minister of Posts and Telegraphs, has arrived in London.

HONOURS TO ELECTRICIANS.—Dr. Werner Siemens has had the gold medal for Industrial Merit conferred upon him by the German Emperor. The Albert gold medal of the Royal Society of Arts, "For distinguished merit in promoting Arts, Manufactures, or Commerce," has been awarded this year to Sir William Thomson, "On account of the signal services rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

A SILVER medal has also been awarded, by the Society of Arts, to Mr. Conrad Cooke, for his paper on "Edison's New Telephone."

CAPE TELEGRAPHY.—The *Kangaroo* had not begun to lay the first section of the Cape cable, from Durban to Zanzibar, up to June 17. The *Standard* correspondent, writing from Landsman's Drift, June 15, states that the land wire, as laid by Major Hamilton and Lieutenant M'Gregor, and the C. Troop Royal Engineers, will be completed very shortly to Doornberg. The work has been carried out with great zeal and activity; but the company must now, so far as regards the further laying of the telegraphs, remain idle, the War Office, having, with its usual prescience, sent out a well-organised body of officers and men, with plenty of working material, but omitted to send sufficient wire. He also reports that the demand was made by the corps for 100 miles of semi-permanent wire, which, if laid, would have stood the whole campaign. The field wire has now joined the colonial wire at Ouggar's Kraal, through Dundee and Landsman's Drift to Doornberg. These places will be in telegraphic communication, by signals, with a position, chosen by M'Gregor, of the Engineers, near Lord Chelmsford's headquarters. Had the home authorities sent sufficient wire from Europe there would have been direct communication to Chelmsford with all stations throughout the country. The men of the Royal Engineers, working the telegraphs, have had very heavy work, owing to the quantity of Government and Press work telegraphed.

THE FRENCH ATLANTIC CABLE.—Some 345 knots of the Brest to Nova Scotia section of this cable have been successfully laid by the *Faraday*, which has returned to Brest after buoying the sealed end at Scilly.

ELECTRIC CONDUCTIVITY IN TOURMALINE CRYSTALS.—Prof. Sylvanus Thompson and Dr. O. J. Lodge have been experimenting to determine whether pyro-electric crystals possess unilateral conductivity for electricity, with a view to test the hypothesis of Sir. W. Thomson that the internal polarisation of the crystal is a sufficient cause of the phenomenon of pyro-electricity. Unilateral conductivity is defined as follows:—Let a certain direction from a point A to a point B in a homogeneous substance be considered. Then if it is found that the resistance to the passage of electricity (or heat) is greater or less when the flow is in the direction A B, than it is when in the direction B A, such a substance possesses a unilateral conductivity for electricity (or heat, as the case may be) in the given

direction. Dr. Thompson finds that the ratio of the two conductivities in opposite directions through a tourmaline crystal when it is becoming hotter is roughly as 100 to 119. The more rapid flow is toward that pole which when the crystal is warmed becomes positively electrical. The faces A B, of the crystal-slice experimented upon corresponded to the antilogous and analogous poles of the original crystal. Dr. O. J. Lodge found a similar effect, and that with a fall of temperature there was a difference of conductivity in the other direction, while with a constant temperature, no difference could be perceived. It therefore appears that in a pyro-electric crystal whose temperature is rising, heat flows more easily *with* the electricity (i.e., from the antilogous to the analogous pole) than it does against the electricity. This "convection of heat by electricity," says Dr. Lodge, "has an apparent analogy with the effect predicted and verified by Sir William Thomson in unequally heated metals (Bakerian Lecture 1856), and which might equally well be called the *convection of electricity by heat:* and it must have an interesting bearing on the theory of Prof. Kohlrausch concerning, 'Thermo-Electricity and Heat Conduction,' set forth in *Poggendorf's Annalen*, vol. 156, p. 601."

CLEANING ELECTRODES.—MM. Beilstein and Sawein, of St. Petersburgh, have found that metal electrodes are kept clean by being well rubbed with oleonaptha, a lubricating oil prepared from Caucasian petroleum, and sold by Ragosin, in Nischny Novgorod. The residual oil opposes very little resistance to the current.

NITRIC ACID IN BATTERIES.—Mr. J. H. Knight states in a letter to *Nature*, that a mixture of half nitric and half dilute sulphuric acid is preferable to nitric acid alone in Bunsen and Grove batteries, since it gives off less fumes and by decreasing the internal resistance increases the current, at least to begin with.

GREASED ZINC IN BATTERIES.—M. Bandechon, writing in *L'Electricite*, states that he has found a sulphate of copper battery with the zinc cylinder slightly greased on the outside surface next the vessel, and a mixture of vinegar and salt for the solution, to give a stronger current than the ordinary Daniell.

BREAKING-IN HORSES BY ELECTRICITY.—The Omnibus Company of Paris have for many years employed a feeble induction current passed through the mouths of vicious horses as a means of taming them. In the Swedish section of the Paris Exhibition there was shown an apparatus for this purpose consisting of a small battery and induction coil, contained in a box about 4 inches long, and having leading wires to pass along the reins. The effect of the current is to produce a kind of paralysis in the animal all at once.

THE MARIE-DAVY AND CALLAUD BATTERIES.—M. E. Caïl has, from numerous comparative experiments, been led to advise the French Telegraph Administration to suppress the small Callaud element, the larger being, however, retained because of its powerful current and capacity for chemicals. A battery of 650 Callaud elements has been replaced at Lille by 1,440 other elements. The Marie-Davy is recommended by M. Caïl when the mercury in it is of good quality; but the Leclanché is preferred to it, and has a distinct place marked out for it in offices of the second class.

TELEGRAPH POSTS IN COCHIN-CHINA.—For temporary lines bamboo is sometimes employed, but they cannot withstand the long-continued action of the dry and wet alternations of climate in these regions. The best posts are made of "tram" (white and red), a wood which is remarkably durable in water and moist earth. It is a kind of eucalyptus, but instead of being a febrifuge it is said to cause fever when growing in masses, and is known as fever-wood. The "viap" is excellent for poles set in damp places; the "sao," the "lau tau," which endures for over fifty years in dry soil, and the "sheu." These last three furnish posts from thirty to sixty feet long.

MACHINE FOR TESTING TELEGRAPHIC POLES.—The French Commission appointed in 1875 to study the question of employing iron poles on telegraph lines, have designed a new machine for measuring the bending stress on these poles when in an erect condition. It has been constructed by M. Thomasset, Paris, and consists of an erect iron frame for stressing the upright pole by means of a horizontal rope, and a mercury manometer for measuring the stress.

ROTARY MAGNETIC POWER OF GASES.—M. Henri Becquerel finds that lighting gas, sulphide of carbon vapour, oxygen, and other gases shift the plane of polarisation of light under a powerful magnetic influence. Oxygen behaves like a highly magnetic body, and gives a negative rotation. M. Bichat also finds that the vapour of sulphide of carbon gives a decided result of this kid.

A "South Jersey Telegraph Company" is also being organised at Camden, N. I. United States.

THE TELEGRAPH IN ARIZONA.—The railroad wire (leased by the Western Union) has been extended eastward through Arizona. It has now reached beyond the Gila river, 82 miles east of Fort Yuma, which latter is said to be the hottest spot on earth, to the place known as Maricopa Wells in the centre of Arizona, and construction has been suspended during the hot season, until cooler weather in the fall. Within a twelvemonth or so, it is anticipated that the overland and all-rail trip can be made by this southern route.

VARLEY'S ELECTRIC HARMONIUM.—This consists of a gamut of tuning forks arranged as spring contact-breakers. A key-board is attached, and the depression of any key directs the current through an electro-magnet, under the influence of which the fork applied to it vibrates, and the corresponding fork is thereupon set into similar vibration. The feeble tones of the fork were much increased when a telephone was placed in circuit, and was still further increased when the telephone was replaced by a piece of apparatus acting like a Leyden jar, and consisting of a sheet of thin gutta-percha, with perforated zinc on one side, and thin tin-foil on the other.—*Proceedings of Newcastle Chemical Society.*

ELECTRO-BRONZED IRON.—A process for covering iron with a durable coating of bronze by electrolysis has been patented by the Philadelphia Smelting Company. The articles to be bronzed are first put into a bath of paraffin, which stops further oxidation. They are then coated with a metallic matter and immersed in the electro-bronzing bath. When taken out they are treated with a protecting varnish before being ready for use. The "deoxidised bronze" employed is an alloy of copper and tin, highly malleable, and capable of a smooth finish.

THE THERMAL AND GALVANOMETRIC LAWS OF THE ELECTRIC SPARK IN GASES.—To study this subject M.

Villari has constructed a glass globe thickly coated with shellac, and furnished with four tubes, two vertical and two horizontal. These last are traversed by two brass electrodes, interiorly terminated by short wires of platinum or silver, with knobs of silver or platinum, and exteriorly terminated by brass balls. To the upper tubes is fitted a cock which allows different gases to be introduced. To the lower tube is fitted a long glass tube, of about 3 mm. diameter externally. This last tube is maintained vertical and plunged at its lower extremity in a glass which holds a mixture of glycerine and water. The apparatus is enclosed in an insulating box. This novel thermometer was placed in the circuit of a battery of eighteen Leyden jars. In the same circuit is placed also an electrometer jar, and a hand key. The battery was charged by the aid of a Holtz machine; the discharge produced a spark in the globe, and the heat resulting from it depressed the level of the glycerine in the vertical tube. With this apparatus (the electrometer serving to measure the quantity of electricity furnished by the battery), M. Villari finds that for nitrogen, oxygen, hydrogen, and carbonic acid (1) the heat developed in the gas by an electric spark is directly proportional to the quantity of electricity which produces the spark. With a galvanometer in circuit, M. Villari also found that (2) the deflections produced by the discharges of the jar were proportional to the quantities of condensed electricity. Further (3) the deflections produced by the discharge of condenser are constant and independent of the length of the spark produced in any part of the circuit; (4) the quantity of heat developed in a gas by the electric spark increases in proportion to its length, a result which implies that the temperature of the spark at its different points is independent of its length, and that the electric resistance of the gas is proportional to the thickness of the gaseous bed traversed by the discharge. (5) When the charge which produces the spark remains the same the quantity of heat developed by that spark is independent of the surface of the condenser. (6) The galvanometric deflections produced by the discharge of a condenser is independent of its surface. To sum up, the thermal and galvanometric deflections produced by spark or by discharge of condenser, are proportional to the quantity of electricity which produces them, and at the same time to the length of their active circuits, that is, the length of the spark or the length of the galvanometer wire.

## Review.

*Fragments of Science: a series of detached Essays, Addresses, and Reviews*, by JOHN TYNDALL, F.R.S. 6th Edition. Longmans & Co., London.

FOR clear cut thought, lucid style, and felicitous words Prof. Tyndall is admittedly the best of our scientific writers; and in these two handsome volumes he has embodied all his shorter masterpieces. Here will be found his famous Belfast Address which shocked, and reasonably shocked, so many theologians at the time it was delivered, and called forth an avalanche of criticism on the daring climber who had scaled the Alpine heights of Materialism and brought back tables of stone, inscribed with nothing, to his generation. And here too, will be found his replies to that criticism, together with papers descriptive of trips to Algeria, Niagara, and other well-known places often described by artists but seldom by a man of science. The author's speculations on vitality, the nature of man, the efficacy of prayer, are profoundly interesting, but with all the incisive logic and trenchant phrase which Prof. Tyndall brings to bear upon them, the reader has still a comfortable feeling, that there is something in prayer and vitality which eludes the critic s mechanical analogy and the vivisector's knife. Modern Materialism could hardly find a more eloquent exponent than Dr. Tyndall; but, after all, the soul is a thing which defies the prying of a physicist, and the tests of a laboratory. The recent Royal Institution lecture on the electric light concludes the book.

## New Patents—1879.

2238. "Improvements in apparatus for transmitting and receiving signals, orders, or messages, for use on board steam and sailing ships and in mines, buildings, and other places." J. S. STARNES. Dated June 6.

2301. "Apparatus for electric lighting." R. WERDERMANN. Dated June 10.

2321. "Apparatus for the production and regulation of electricity applied for illumination." J. D. F. ANDREWS. Dated June 11.

2322. "Electric lamps." C. D. ABEL (communicated by H. Sedlaczek and F. Wikneill). Dated June 11.

2339. "Improved means of obtaining light by electricity." A. M. CLARK (communicated by A. de Méritens & Co.). Dated June 12.

2340. "Electrodes used in the production of the electric light." A. M. CLARK (communicated by C. J. P. Desnos). Dated June 12.

2397. "Improvements in joining telegraph and fencing wires and other wires and strips of metal, and in joining wires to rings or hooks for hanging pictures and for other like purposes." J. SHELDON. Dated June 17.

2402. "Improvements in electric lights and in apparatus for developing electric currents and regulating the action of the same." T. A. EDISON. Dated June 17.

2481. "Apparatus for the transmission of power by electricity." J. HOPKINSON. Dated June 21.

2497. "Transmitters for telephones." A. MARR. Dated June 21.

2543. "Improvements in the manufacture of carbon candles or points, and of carbon plates for electric lighting and other purposes." F. J. DE HAMEL. Dated June 25.

2554. "Improved means and apparatus for producing motive power chiefly for the rotation of magneto-machines used for lighting purposes." J. B. ROGERS. Dated June 25.

2575. "Telegraphic apparatus for railways." E TYER. Dated June 26.

2600. "Receiving apparatus for telephonic communication." F. A. ORMISTON (communicated by H. M. McIntire). Dated June 27.

2629. "An improved submarine telegraphic cable.' A. BLONDOT, J. BOURDON. Dated June 30.

2652. "Electric lamps." C. W. SIEMENS (communicated by F. Von Hefner Alteneck). Dated July 1.

2654. "Telegraphic apparatus." E. C. WARBURTON, L. J. CROSSLEY. Dated July 1.

2656. "Means and apparatus for immersing submarine telegraphic cables." A. BLONDOT, J. BOURDON. Dated July 1.

---

## ABSTRACTS OF PUBLISHED SPECIFICATIONS.—1878.

3676. "Magnets and armatures for producing motive power." H. E. NEWTON. Dated Sept. 17. 6d. A disc of metal or other material carrying a number of armatures is made to revolve either in a horizontal or vertical direction. A number of magnets equal to the number of armatures are arranged round it and each is attracted in succession by the permanent magnets. Each of the latter is temporarily neutralised after performing its attractive duty.

3707. "Galvanic batteries." C. E. BASEVI. Dated Sept. 19. 2d. This describes a zinc-carbon element in a corked vessel which prevents escape of free hydrogen. *(Not proceeded with.)*

3713. "Galvanic batteries." J. D. ADAMS (communicated by Alfred Niaudet, Paris). Dated Sept. 19. 6d. In this battery chloride of lime is the depolarizing salt. The zinc pole is plunged in a solution of common salt and water: the carbon pole is surrounded with chloride of lime in a porous jar; the battery is enclosed in a hermetically sealed box.

3744. "Telegraphing on board ship." E. A. CAMINADA. Dated Sept. 21. 6d. This describes a plan for telegraphing the position of the rudder or other information on board ship by means of electricity.

3892. "Telephones." J. H. JOHNSON (communicated by F. A. Gower and C. Roosevelt, Paris). Dated Oct. 3. 6d. This describes Gower's well-known telephone call by means of a reed in the diaphragm. *See* TELEGRAPHIC JOURNAL, March 1.

3916. "Microphonic speaking apparatus." C. F. VAREY. Dated Oct. 4. 2d. The apparatus consists of a carbon pencil microphone enclosed in a case. The air inside the case is set in vibration by the voice by means of a diaphragm in one side of the case.

3923. "Construction of electro-magnetic letter indicating and type printing telegraph instruments." W. E. IRISH. Dated Oct. 5. 6d. The object of this invention is to render type printers self-acting, requiring no train of clockwork, all the work being done by a simple electrical make and break action.

3924. "Electrical apparatus for telegraphic and similar purposes." S. F. V. CHOATE, New York. Dated Oct. 5. 8d. This describes a plan for facilitating working on submarine cables by means of repeaters sunk in hermetically sealed globes at a point on the cable between the sending and receiving stations.

3930. "Telephonic apparatus for domestic and other uses." J. H. MCLURE. Dated Oct. 5. 6d. This describes an indicator for central telephone stations common to all the circuits.

3960. "Telegraphic transmitting, receiving, and call apparatus." J. F. BAILLEY. Dated Oct. 8. 6d. This apparatus works without a battery by the induction produced by rapid separation of an armature from the poles of a magnet. It is both receiver and transmitter and contains two armatures, one of which is moved by the operator in order to produce a signal in the line, the other under the influence of currents in the line strikes out signals.

3971. "Connecting the ends of wire for continuous fencing, electric telegraphs, &c." G. and E. WOODS. Dated Oct. 9. 6d. This consists in a mode of jointing wires by nipping the two ends between metal surfaces of a connecting piece.

3976. "Magneto-electric machines." M. R. WONDE. Dated Oct. 9. 6d. This consists in forming the armatures of magneto-machines in such a way that the pole pieces of the magnets and the core of the armature are close together. This is done by nicking out the core of the armature and winding the coils in the niches.

3988. "Electric lighting, &c." ST. G. L. FOX. Dated Oct. 9. 6d. This consists in making an incandescent lamp from a strip of platinum or platinum-iridium alloy. On each side of this strip is placed a sheet of mica or talc to prevent cooling of the strip by the atmosphere. A spiral coil of foil with a tube of talc, kaolin, glass, steatite, or lime, within the spiral, and with a tube of talc, glass, &c., just covering it outside is also used. By increasing the width or number of strips more volume of light is obtained, by shortening them, more intensity. Planté secondary batteries may be used at the main and the earth.

4006. "Electric lighting apparatus." P. DENSEN (communicated by Siegfried Marcus, Vienna). Dated Oct. 10. 6d. This describes an incandescent carbon lamp similar to Reynier's and Werdermann's. A vertical carbon pencil rubs upon a rotating cylinder of carbon, and the current passing from the pencil to the cylinder causing the point of the former to glow. The pencil is pressed forward as it consumes by a weight and pulley.

4007. "Electric clocks." R. H. BRANDON (communicated by C. W. Firnhaber, Paris). Dated Oct. 10. 6d. This describes an electro-magnetic arrangement for regulating clocks by a motor clock.

4016. "Electric lighting, heating, and motive power apparatus." JOHN MUNRO. Dated Oct. 11. 4d. This consists of a current divider or distributor for the electric light, capable of feeding a large number of separate lamps, without interference of one light with another. It is based on the principle that if the current supplying a lamp be an intermittent one whose pulsations succeed each other a sufficient number of times per second the effect is the same as if it were a continuous current. A shaft connected to the source of electricity revolves with great rapidity and distributes the current to a series of branch circuits set radially round the shaft, one after another by means of brushes, cams, or helical contacts. This shaft may be driven by clockwork or electricity &c. Besides the rotating shaft, oscillating shafts, levers, and vibrating bodies, such as tuning-forks, may be used to distribute the current. The divider may be placed beside the generator, or at a distance from it, in a house, so as to supply a given number of lights. The intermittent currents from the divider are rendered continuous again, or nearly so, by being passed through induction apparatus and secondary batteries. *(Not proceeded with.)*

4022. "Arrangements for electric lighting." J. W. T. CADETT. Dated Oct 11. 4d. This consists of a current regulator in which a carbon resistance dipping into mercury is inserted in the circuit of the lamp. By means of electro-magnetism this carbon is plunged more or less in the mercury according to the strength of the current, thereby interposing more or less resistance in circuit.

4031. "Softening or diffusing electric and other light." A. M. CLARK (communicated by L. Clémandot, Paris). Dated Oct. 11. 6d. This consists in using globes formed of two shells with glass wool between.

## SOUTH AFRICAN TELEGRAPHY.

TELEGRAPHY is making great strides in South Africa. Early in January last the line from Durban to Fort Pearson was opened. In February the grand trunk line from Maritzburg, inland to Pretoria was commenced, and it was completed and opened as far as Utrecht in the Transvaal in the middle of May. The telegraphic communication is now complete from the Zulu border at its two extreme points, the south-east and the north-west to Cape Town. The advantages accruing in a military sense from such a fact are self-evident; they cannot be over estimated. The credit of this most useful work is due to the untiring energy and able organising power of Mr. Sivewright, in whose hands is now vested the general management of South African telegraphs in both the Cape Colony and Natal.

The *Natal Mercury* on this subject says:—Mr. Sivewright may be regarded as the practical harbinger of Confederation, as he has done more to unite the erewhile separated communities of South Africa, and to identify their interests and concerns, than any living man. Most effectively aided by his indefatigable constructor, Captain Fraser, he has brought the Cape and Natal, the Diamond Fields and the Cape, Natal and the Transvaal, Zululand and Natal, within speaking range of each other. He has done this in spite of apathy, sloth, and division amongst ourselves, and he deserves all the credit and thanks that we can accord him for valuable services zealously and successfully rendered.

## Proceedings of Societies.

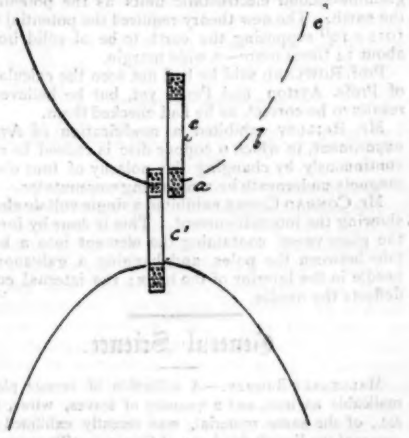
### PHYSICAL SOCIETY.—JUNE 28TH, 1879.

Prof. W. G. ADAMS in the Chair.

PROF. W. G. ADAMS described his New Measuring Polariscope. The polariscope consists of three principal parts. The lowest section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of similar lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these, there is a middle piece, consisting of two lenses (nearly hemispheres) forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through any angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle with its centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and central lenses can be turned about each of three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rim of the central lenses the crystal and central lenses may be turned separately about the optical axis of the instrument, so as to bring the plane of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Sir John CONROY, Bt., read a paper on "The Distribution of Heat in the Spectrum." After referring to Dr. T. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that owing to the unequal dispersion of the prism for rays of different refrangibility, the method that has been used for determining the calorific intensity of the various parts of the spectrum, is an essentially defective one. He described a graphical method for eliminating the effects of the unequal dispersion of the prisms, and showed, from MM. Fizeau and Foucault's measurements, and also from those of Jamansky and Professor Tyndall, that the maximum intensity is about the middle of the spectrum and not at the red end; and further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum are in reality the "Dispersion Curves" for the particular prisms employed.

Mr. GRANT then described an investigation which he had made into the induction lines round two parallel coils of wire; in the primary coil an intermittent current of electricity from a Leclanché battery flowed, and in the secondary a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other, there were lines, or rather a surface of minimum induction surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram representing a medial section through the coils showed the lines to proceed from the wire of the coils in two curves resembling parabolas, one from each cross-section of the wire outwards, as shewn in the figure.




Dr. SHETTLE then described his experiments proving the lines of force in a bar magnet to run spirally round the bar between the equator and poles: the equator being decentred and oblique across the bar as shown by diagrams.

Prof. ROWLAND of Baltimore made some observations on the new theory of terrestrial magnetism of Profs. Ayrton and Perry. He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself. On making these experiments out he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but by mutual repulsion drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetisation, but failed to get any effect

from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a charged sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but instead of the result of Messrs. Ayrton and Perry that if the earth were charged to a potential of, he believed, $10^8$ volts relatively to interplanetary space, the earth's magnetism would be what it is. He found the necessary charge to be $61 \times 10^{12}$ volts. In the ordinary atmosphere this potential would produce a spark nine million miles long, and discharge across to the moon. If the moon were electrified to the same degree the mutual repulsion would overcome the force of gravity between them. He therefore considered terrestrial magnetism to be still a mystery.

He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified; the winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis is tenable still.

Prof. AYRTON said that whether or not the new theory of magnetism should be so rejected depended on whether or not, Prof. Rowlands calculations or those of himself and Prof. Perry were wrong. It had been found by Sir William Thomson from experiments at Arran, that the earth was electrified with respect to the earth and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave $1360 \times 10^{12}$ centimetre-gramme-second electrostatic units as the potential of the earth. The new theory required the potential to be $1011 \times 10^{11}$ supposing the earth to be of solid iron, or about 14 times more—a wide margin.

Prof. ROWLAND said he had not seen the calculations of Profs. Ayrton and Perry yet, but he believed his results to be correct, as he had checked them.

Mr. BAILLEY exhibited a modification of Avago's experiment, in which a copper disc is caused to rotate continuously by changing the polarity of four electro-magnets underneath by a revolving commutator.

Mr. CONRAD COOKE exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix; the internal current deflects the needle.

## General Science.

MALLEABLE BRONZE.—A collection of bronze plate as malleable as iron, and a quantity of leaves, wires, tubes, &c., of the same material, was recently exhibited at a *seance* of the French Academy of Sciences. They were produced by a process still kept secret by its inventor, M. Reynier.

MALLEABLE BRASS is made by alloying 33 parts of copper and 25 of zinc, the copper being loosely covered with the zinc in the crucible. As soon as the copper is melted, zinc purified by sulphur is added. The alloy is then cast into moulding sand in the shape of bars, which are malleable into any form when still hot.

COATING COPPER WITH IRON.—Professor Boettger recommends the following solution for coating copper plates with iron. Ten parts of ferro-cyanide of potassium and twenty parts of cartrate of soda are dissolved in 220 parts of distilled water, adding a solution of three parts sulphate of iron in fifty parts of water. Caustic soda solution is then poured into the mixture until the Prussian blue formed is re-dissolved.

M. TOSELLI is the inventor of the bi-automatic grapnel, which, by means of water pressure, either opens out or spurts its flukes round the body it is intended to lay hold of. At Ajaccio recently, a sack of merchandise, weighing 50 kilograms, and at the port of Nantes, a quantity of coal were raised in a few minutes by this grapnel. A closed electric lamp, with a reflector to direct the beam downwards on the flukes, is also fitted over this grapnel to illuminate the bottom in shallow waters.

## City Notes.

Old Broad Street, July 12th, 1879.

EASTERN TELEGRAPH COMPANY.—In anticipation of the meeting, the half-yearly report of this Company has been circulated. It shows a balance of £144,342, from which £14,480 has been paid in interest on debentures, and £20,560 is required for dividend to the 31st March last at the rate of 6 per cent. per annum on the preference shares. An *interim* quarterly dividend of 1½ per cent. has already been paid on the ordinary shares, and it is now proposed to declare a final dividend for the year ended March last of 2s. 6d., making, with three previous payments on account, a total dividend of 5 per cent. for the twelve months. The sum of £16,876 is to be added to the reserve fund, raising it to £175,512. The Telegraph Construction and Maintenance Company have engaged to manufacture and lay the cables between Aden and Natal, and provide a suitable maintenance ship at a cost of £950,000. The work is to be completed by December next. As the directors consider it inexpedient that the Eastern Company should take the entire responsibility of the undertaking, it is proposed to form a separate concern, to be called the Eastern and South African Telegraph Company, with a share capital of £400,000 and mortgage debentures for £600,000.

THE EASTERN EXTENSION COMPANY have declared an *interim* dividend, for the quarter ending March 31st last, of 2s. 6d. per share, or at the rate of 5 per cent. per annum, free of income-tax.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The directors have declared an interim dividend of 12s. per share, or at the same rate as for the corresponding period last year.

The following are the final quotations of telegraphs for the 12th inst.:—Anglo-American, Limited, 54½-55; Ditto, Preferred, 84½-85½; Ditto, Deferred, 26½-27; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 8-8¼; Cuba, Limited, 10 per cent. Preference, 16-17; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10¾-11¼; Direct United States Cable, Limited, 1877, 10¾-10¼; Eastern, Limited, 7⅞-7¼; Eastern, 6 per cent. Debentures repayable October, 1883, 105-108; Eastern 5 per cent. Debentures repayable August, 1878, 103-105; Eastern, 6 per cent. Preference, 11¼-12; Eastern Extension, Australasian and China Limited, 7⅞-7⅞; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; German Union Telegraph and Trust, 7¾-8¼; Globe Telegraph and Trust, Limited, 4¾-5; Globe, 6 per cent. Preference, 10¾-11; Great Northern, 8¼-8½; Indo-European, Limited, 20¼-21¼; Mediterranean Extension, Limited, 2¼-3; Mediterranean Extension, 8 per cent. Preference, 9-9½; Reuter's, Limited, 9-10; Submarine, 225-235; Submarine Scrip, 2-2¼; West Coast of America, Limited, 1-1⅛; West India and Panama, Limited, 1⅛-1¼; Ditto, 6 per cent. First Preference 7⅛-8¼; Ditto, ditto, Second Preference, 7⅛-7⅞; Western and Brazilian, Limited, 3-3⅛; Ditto, 6 per cent. Debentures "A," 96-100, Ditto, ditto, ditto, "B," 88-93; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 118-122; Ditto, 6 per cent. Sterling Bonds, 106-108; Telegraph Construction and Maintenance, Limited, 30¾-31¼; Ditto, 6 per cent. Bonds, 106-108; Ditto, Second Bonus Trust Certificates, 2¼-2⅜; India Rubber Co., 12¼-12⅜; Ditto, 6 per cent. Debenture, 105-108.